

Research Article

Evaluation of Treated Water at Three Adjacent Water Treatment Stations in Al-Hilla City, Iraq by Using CCME Water Quality Index

Layla Abdulkareem Mokif

Department of Civil Engineering, Almustaqbal University College, Iraq

Abstract: In this study, many water quality indices are reviewed. The Canadian Council of Ministers of the Environment (CCME), Water Quality Index (WQI) is used in the assessment of three adjacent water treatment stations. These stations are in Al-Hilla City in Iraq. They are all supplied with raw water from Shatt Al-Hill River. For determining the water quality of these water treatment stations, eight physical and chemical parameters are estimated. The considered parameters are Alkalinity (Alk), Turbidity (Turb.), Chloride (Cl), pH, Magnesium (Mg), Electrical Conductivity (EC), Calcium (Ca) and Total Hardness (TH). Treated water samples were collected and tested regularly for 6 months from the three stations. The calculated results for water quality reveal that all selected water treatment stations are good according to classification of CCME WQI. All the estimated values of the chemical and physical parameters concerning the studied water treatment stations are ranging within the Iraqi standards except turbidity.

Keywords: CCME WQI, water assessment, water quality index, water treatment

INTRODUCTION

Water is one of the most indispensable resources hence life is not possible on this planet without water. A study conducted by Yisa *et al.* (2012) showed that the accelerated global population and the rapid progress of industrialization in different fields throughout the last four decades cause an urgent need for fresh water. The requirements of developing health aspects and the necessary human right issues imply the availability of sufficient safe water. Many diseases caused by the lack of safe water sources, insufficient sanitation and poor hygiene result in 3.4 million victims (most of them are children) a year (Ahuja, 2009). Surface waters can be evaluated with respect to quality and pollution by considering water quality parameters which are determined by processing certain sampled data and presenting results to specialists. Conditions of water quality can simply be evaluated by using methods depending on a concept known as Water Quality Index (WQI) (Yisa *et al.*, 2012; Alobaidy *et al.*, 2010). WQI is an effective indicator for presenting information about water quality to interested persons like ordinary citizens and policy planners (Yisa and Jimoh, 2010). It therefore, becomes an important parameter for evaluating and managing the surface water. WQI can be defined as a rating, which gathers the effects of all parameters of water quality into a single value (Yisa and Jimoh, 2012). It is commuted for deciding the surface water suitability for the purposes of human consumption (Atulegwu and Njoku, 2004). Horton

(1965) was the first person who used the concept of water quality.

Many studies had been conducted on water to evaluate its quality by using water quality indices. Here are some examples of these indices. A study achieved by Sharifi (1990) had used the US National Sanitation Foundation Water Quality Index (NSFWQI) to calculate the quality of water. Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI) had been adopted in the assessment of water quality (Lumb *et al.*, 2002). British Columbia Water Quality Index (BCWQI) and Oregon Water Quality Index (OWQI) were used by Debels *et al.* (2005), Kannel *et al.* (2007) and Abbasi (2002) to evaluate the water qualities in their studies.

In this study CCME WQI has been considered, thus recent works using this index have been reviewed. Al-Janabi *et al.* (2012) showed according to CCME WQI, that the water quality of Tigris River in Iraq had ranged between 37 and 42 in some regions along its flow. According to CCME water quality classification, the water quality of the river in those regions was considered to be poor and this was due to the effects of local pollution. Gyamfi *et al.* (2013) in his study on Aboabo River in Ghana had determined the overall WQI of five different stations on this river to be 17.05 which laid it within the poor classification according to CCME WQI. Using CCME WQI, a study conducted by Munna *et al.* (2013) on Surma River in Bangladesh, showed that the value of WQI was 15.78 which indicated that water quality of that river was Poor and revealingly impaired near Sylhet city. Agrama and El-

Sayed (2013) had conducted a study on different locations at each canal of an agricultural area in Western Delta-Egypt. The water quality in the studied area was classified as marginal according to CCME WQI.

MATERIALS AND METHODS

Study area: This study is conducted to assess some water treatment stations in Al-Hilla City by using CCME WQI. Al-Hilla City is located in the middle of Iraq. The surface water of this city is Euphrates River and all the water treatment stations approached in this study are conventional.

Sampling: Three water treatment stations in Al-Hilla City are considered in this study. These treatment stations are supplied with raw water from Shatt-Al-Hilla which is a branch of Euphrates River. They are supplying drinking water to three separate areas along the flow of Shatt-Al-Hilla. Samples of drinking water were collected from these stations for the period from October 2013 to March 2014. Samples were immediately processed after collection for physical and chemical properties. Eight parameters were used to calculate the water quality index. These parameters were pH, Total Hardness (TH), Calcium (Ca), Alkalinity (Alk), Turbidity (Turb.), Electrical Conductivity (EC), Magnesium (Mg) and Chloride (Cl). The Iraqi recommended Guidelines for drinking water specifications are stated in Table 1.

Measurement of water quality using CCME WQI: WQI can be defined as a mathematical tool transforming large quantities of data obtained from physical and chemical properties of water into a single number representing the level of water quality (Bharti and Katyal, 2011). In this research CCME WQI was used to calculate the water quality. This index can be determined as follows (CCME, 2001):

- F1 is called Scope which represents the percentage of variables that do not meet their objectives at least once during the interval under consideration ("failed variables"), relative to the total number of variables measured:

$$F_1 = \left[\frac{\text{Number of failed variables}}{\text{Total number of variables}} \right] \times 100 \quad (1)$$

- F2 is called Frequency which represents the percentage of failed tests:

$$F_2 = \left[\frac{\text{Number of failed tests}}{\text{Total number of tests}} \right] \times 100 \quad (2)$$

- F3 is called Amplitude, which represents the deviations of the failed tests from their objectives. It is determined as follows:

Table 1: Iraqi standards for drinking water, 2001

Parameter	Unit	Iraqi standards
Turbidity	NTU	5
pH	-	6.5-8.5
Electrical conductivity	µs/cm	2000
Chloride (Cl)	mg/L	350
Calcium (Ca)	mg/L	150
Alkalinity (Alk.)	mg/L	125-200
Magnesium (Mg)	mg/L	100
Total Hardness (TH) as CaCO ₃	mg/L	500

Table 2: CCME WQI classification (Haseen *et al.*, 2005)

Rank	Value of WQI
Poor	0-44
Marginal	45-64
Fair	65-79
Good	80-94
Excellent	95-100

- The term "Excursion" represents the number of times that certain concentration is different from the objective. When the value of the test is less than the objective, Excursion is given by:

$$Excursion = \left[\frac{\text{Failed Test value}}{\text{Objective}} \right] - 1 \quad (3)$$

When test value is greater than the objective, Excursion is given by:

$$Excursion = \left[\frac{\text{Objective}}{\text{Failed Test Value}} \right] - 1 \quad (4)$$

- The sum of exertions of individual tests divided by the total number of tests is called normalized sum of excursions (*nse*) and is computed as follows:

$$nse = \left[\frac{\sum_{i=1}^n \text{Excursion}}{\text{Number of tests}} \right] \quad (5)$$

- F3 is a function of *nse* and is given by:

$$F_3 = \left[\frac{nse}{0.01 + 0.01nse} \right] \quad (6)$$

Finally CCME WQI is calculated as follows:

$$CCMEWQI = 100 - \left[\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right] \quad (7)$$

The water quality is ranked according to CCME WQI as stated in Table 2.

RESULTS AND DISCUSSION

The calculated results for pH varied from 7.5 to 7.8 in station (1), 7.6 to 8.05 in station (2) and 7.4 to 8 in

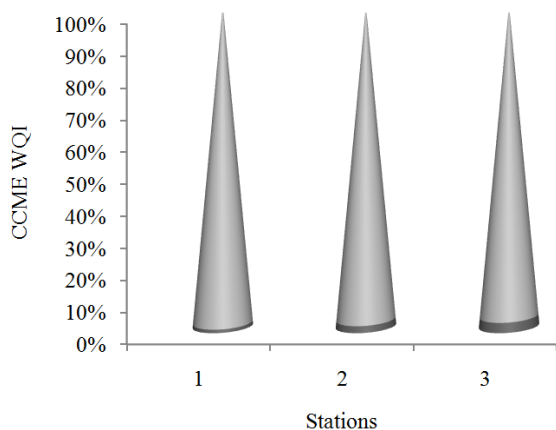


Fig. 1: The water quality index for the assessed water treatment stations

station (3). The above values of pH indicate that the water samplers are almost neutral to sub-alkaline in nature. The observed values of Alkalinity were (101-132), (101-121) and (95-109) mg/L for stations 1, 2 and 3, respectively. The values of chloride were (105-125), (105-116) and (110-130) mg/L for stations 1, 2 and 3, respectively. The calculated results showed the values of calcium were (91-119), (86-119) and (85-115) mg/L for stations 1, 2 and 3, respectively. The values of electrical conductivity were (1080-1400), (1060-1410) and (880-1337) $\mu\text{s}/\text{cm}$, respectively. Turbidity values were in the range of (0.7- 6), (2.16-13.71) and (1-7.05) NTU for stations 1, 2 and 3, respectively. The values Total Hardness were (329-442), (395-493) and (341-481) mg/L for stations 1, 2 and 3, respectively. The calculated values of CCME WQI were 92.687 for station (1), 91.892 for station (2) and 92.675 for station (3) which indicated that water quality can be rated as good in all stations according to CCME WQI classification. The calculated water quality values for the studied water treatment plants are plotted in Fig. 1.

CONCLUSION

The calculated results showed that the water quality of treated water at all stations were good according to the CCME classification during the study period. All values of selected parameters were within the Iraqi standards for drinking water except turbidity.

REFERENCES

Abbasi, S.A., 2002. Water quality indices, state of the art report. National Institute of Hydrology, Scientific Contribution, No. INCOH/SAR-25/2002, INCOH, Roorkee, pp: 73.

Agrama, A.A. and E.A. El-Sayed, 2013. Assessing and mapping water quality (Case study: Western Delta -Egypt). *Int. Water Technol. J.*, 3(3): 158-169.

Ahuja, S., 2009. *Handbook of Water Purity and Quality*. 1st Edn., Academic Press, Amsterdam, New York.

Al-Janabi, Z.Z., A.R. Al-Kubaisi and Al-Obaidy and A.H.M.J. Al-Obaidy, 2012. Assessment of water quality of tigris river by using water quality index (CCME WQI). *J. Al-Nahrain Univ.*, 15(1): 119-126.

Alobaidy, A.H.M., B.K. Maulood and A.J. Kadhem, 2010. Evaluating raw and treated water quality of tigris river within Baghdad by index analysis. *J. Water Resour. Protect.*, 2: 629-635.

Atulegwu, P.U. and J.D. Njoku, 2004. The impact of biocides on the water quality. *Int. Res. J. Eng. Sci. Technol.*, 1: 47-52.

Bharti, N. and D. Katyal, 2011. Water quality indices used for surface water vulnerability assessment. *Int. J. Environ. Sci.*, 2(1): 154-173.

CCME (Canadian Council of Ministers of the Environment), 2001. *Canadian water quality guidelines for the protection of aquatic life: CCME water quality index 1.0*. Technical Report, Canadian Council of Ministers of the environment Winnipeg, MB, Canada.

Debels, P., R. Figueroa, R. Urrutia, R. Barra and X. Niell, 2005. Evaluation of water quality in the Chilla'n River (Central Chile) using physicochemical parameters and a modified water quality index. *Environ. Monit. Assess.*, 110: 301-322.

Gyamfi, C., R. Boakye, E. Awuah and F. Anyemedu, 2013. Application of the CCME-WQI model in assessing the water quality of the Aboabo River, Kumasi-Ghana. *J. Sustain. Dev.*, 6(10): 1-7.

Hasene, K., A.K. Amir and H. Sarah, 2005. The Canadian water quality index: A tool for water resource management. *Proceeding of the MTERM International Conference*. June 06-10, Ait, Thailand.

Horton, R.K., 1965. An index number system for rating water quality. *J. Water Pollut. Con. F.*, 37(3): 300-306.

Kannel, P.R., S. Lee, Y.S. Lee, S.R. Kanel and S.P. Khan, 2007. Application of water quality indices and dissolved oxygen as indicators for river water classification and urban impact assessment. *Environ. Monit. Assess.*, 132: 93-110.

Lumb, A., D. Halliwell and T. Sharma, 2002. Canadian water quality index to monitor the changes in water quality in the Mackenzie river-great bear. *Proceeding of the 29th Annual Aquatic Toxicity Workshop*. Whistler, B.C., Canada.

Munna, G.M., M.M.I. Chowdhury, A.A.M. Ahmed, S. Chowdhury and M.M. Alom, 2013. A Canadian water quality guideline-water quality index (CCME-WQI) based assessment study of water quality in Surma river. *J. Civil Eng. Constr. Technol.*, 4(3): 81-89.

- Sharifi, M., 1990. Assessment of surface water quality by an index system in Anzali Basin. Proceeding of the Beijing Symposium of Hydrological Basis for Water Resources Management. IAHS Publication, 197: 163-171.
- Yisa, J. and T. Jimoh, 2010. Analytical studies on water quality index of River Landzu. *Am. J. Appl. Sci.*, 7(4): 453-458.
- Yisa, J., T.O. Jimoh and O.M. Oyibo, 2012. Underground water assessment using water quality index. *Leonardo J. Sci.*, 21: 33-42.